VARIATIONS OF GLACIERS. XIX[1]

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The following is a summary of the *Eighteenth Annual Report* of the International Committee on Glaciers.[2]

THE REPORT OF GLACIERS FOR 1912

Swiss Alps.—The tendency of the Swiss glaciers to advance, which began in 1910, and which disappeared in 1911, following the wonderfully clear summer of that year, again became evident in 1912 (and more definitely than in 1910), probably on account of the very cold and wet summer of 1912. Although the number of glaciers retreating is still larger than the number of those advancing the former number is diminishing and the latter increasing.

Eastern Alps.—The heavy snowfall, the low summer temperature, and the hazy condition of the atmosphere reduced the melting during the summer to such an extent that even in August the glaciers were still covered with snow to their ends. One would expect, as a consequence, a marked advance of the glaciers, but this was by no means the case; of the thirty-four glaciers observed, fully twenty-eight were clearly in retreat, three were stationary and only three (and they were small) were advancing. Whether the advance of these three was due to the conditions holding during this one summer, or whether it is the forerunner of a general advance must be determined by the future. We can summarize by saying that the retreat of the glaciers of the Eastern Alps continues, but to a less marked degree than last year.

Italian Alps.—Observations were made in the Piedmont, the Lombard, and the Venetian Alps; they were greatly interfered with by the heavy snowfall, but the glaciers still continue to retreat.

French Alps and Pyrenees.—The tendency of the glaciers to advance, shown in 1911, has not been maintained in 1912. Some

[1] Earlier reports appeared in the *Journal of Geology*, III–XXI.

[2] *Zeitschrift für Gletscherkunde*, VIII (1913), 42–62.

glaciers show slight advances, others slight retreats. The snowfall was very heavy, but it has not yet affected the extent of the glaciers. In the basin of the Gave de Pau, Pyrenees, the snowfall in the winter of 1911–12 was small, but on account of the small summer melting very many of the glaciers remained covered with snow at the end of the summer. The glaciers increased in thickness especially in their reservoirs. On the whole, the glaciers observed have shown for several years a definite tendency to advance.

Swedish Alps.—The two glaciers observed show some slight advance.

Norwegian Alps.—All the glaciers of the Jotunheim are retreating. In the Folgefon and Jostedalsbrae, along the west coast, eighteen glaciers are retreating and six are advancing. In the more northerly regions eight are retreating and three are advancing. A larger proportion of the glaciers under observation were retreating in 1911 than in 1912.

Greenland.—A small tongue of the inland ice near Disco Bay experienced an advance which culminated in July, 1912. Later in the summer the ice had retreated. The large tongue in the same neighborhood, called the Ekip Sermia, seemed to be stationary. The number of icebergs in the Jacobshavn Fiord was becoming smaller. Three small glaciers on Disco Island, first described by Chamberlin in 1894, and mapped in 1897, have since that date retreated between 30 and 80 meters. There are also other indications of the diminution of the glaciations. Recent moraines in front of several glaciers in Sermilik Fiord show that these glaciers are retreating.

REPORT OF THE GLACIERS OF THE UNITED STATES FOR 1913

The Arapahoe Glacier, in Colorado, shows no appreciable change (Henderson).

Professor Lawrence Martin sends me the following information regarding the variations of Alaskan glaciers in 1913:

Glacier Bay.—Several glaciers in this fiord were studied by the writer in 1913, under the auspices of the National Geographic Society. Grand Pacific Glacier, which retreated 7,425 feet between June 1 to August 1, 1912, had advanced 4,000 feet by September 9, 1913, so that it again terminates south

of the International Boundary. De Margerie Glacier and the Reid and Lamplugh glaciers at the upper end of Glacier Bay were likewise active and advancing, the two latter moving forward half a mile from 1911 to 1913. Rendu Glacier retreated about 4,100 feet from 1911 to 1913. The adjacent cascading glacier, which was advancing in 1911, was retreating, and no longer reached tide water in 1913. The southwesternmost tributary of Rendu Glacier advanced in 1913 and pressed out the medial moraines of the Rendu. A cascading glacier on the east was probably also advancing.

Adams Glacier in Muir Inlet retreated about 3,575 feet from 1907 to 1913. Muir also continued to recede. It was more accurately mapped in 1913 than at any time since 1892. Its total recession between these dates was about $7\frac{3}{4}$ miles. Its decrease in thickness is notable; according to Reid's Survey, the ice surface was 1,500 feet above sea-level in 1892 at the site of the ice-front of 1913; and nunataks, 1,050 and 1,150 feet high, were, at the earlier date, covered by ice to depths of 400–600 feet. Soundings in Muir Inlet in 1913 revealed a depth of 1,128 feet at a point where the ice surface was 1,250 feet above sea-level in 1892. Thus the total thickness of Muir Glacier $5\frac{5}{8}$ miles from its 1892 terminus is now known to have been 2,378 feet. Soundings likewise show that in Tarr Inlet (at the upper end of Glacier Bay) the ice of Grand Pacific Glacier at a point 12 miles from the terminus of 1894 was at least 2,500 feet thick.

Near Lynn Canal.—R. G. McConnell reports that the Rainy Hollow or Sullivan Glacier had advanced about 2,000 feet before it was observed in 1910 by Webster Brown, making a total advance of about three-quarters of a mile in less than ten months. It receded slightly between 1910 and 1913. Jarvis Creek Glacier likewise advanced in 1910. The detailed map of the Mendenhall, Eagle, Herbert, and adjacent glaciers east of Lynn Canal,[1] is accompanied by cursory notes on these ice tongues by Knopf.

Yakutat Bay.—Since 1910 Hidden Glacier has retreated 400–500 feet at the terminus and thinned 150 feet or more at the north margin. The tidewater terminus of Nunatak Glacier retreated slightly from 1912 to 1913. The adjacent cascading glacier advanced several hundred feet from 1910 to 1913. Hubbard Glacier receded slightly. Turner Glacier suffered a more pronounced diminution, especially at its south margin.

Mount St. Elias Region.—North of Mount St. Elias the Logan-Chitina Glacier changed from spasmodic, earthquake-stimulated activity in 1912 to stagnation in 1913, as reported by D. W. Eaton and J. D. Craig of the International Boundary Surveys. Its margin receded 30–50 feet during the year. A number of the ice tongues south of Logan Glacier were first mapped in 1913. The surveyors saw no unusual activity between Logan Glacier and Mount St. Elias but report that ablation during cloudy, rainy weather in July lowered the ice surface at a measured rate of between 3 and 4 inches per day.

[1] *Bull. No. 502, U.S. Geol. Survey,* 1912.

The new Icy Bay at the western border of Malaspina Glacier was mapped in 1913 by A. G. Maddren of the United States Geological Survey. The recession of Guyot Lobe now amounts to nine or ten miles. Maddren's map indicates that the Bering Glacier, which has hitherto been considered a single piedmont ice mass, is really two separate piedmont bulbs (Coast Survey Chart 8002, edition of March 12, 1912). A similar condition at Grand Plateau Glacier was noted from close inshore by the special steamer of the International Geological Congress of 1913. In both cases the earlier mapping was in error, for there has been no recession of either the Grand Plateau Glacier or the Bering Glacier in historical times.

Copper River Canyon.—The Childs Glacier has retreated slightly and its northern margin, as measured by Caleb Corser, is now 1,500 feet from the railway bridge on the Copper River & Northwestern Railway. In spite of an advance of more than 60 feet in the interval, its net change, from June 16, 1911, to July 12, 1913, was a recession of 26 feet, and from the latter date to November 7, 1913, it retreated between 100 and 150 feet more. Allen Glacier, after a slight advance in 1912, began to recede in 1913. Between August 26, 1910, and July 12, 1913, it advanced 2650 feet, or four-tenths of the distance to the railway north of it. From the latter date to October 28, 1913, Corser's measurements show that its northwestern border retreated 300–700 feet. Schwan Glacier is said by a prospector to have advanced in 1912.

Wrangell Mountains.—In connection with her successful ascent of Mount Blackburn in 1912,[1] Miss Dora Keen made important observations of snowfall and temperature, giving an idea of the precipitation that supports the large Kennicott Glacier. The total snowfall for thirty-three days (April 22 to May 24) was 40 feet (packed to 20 feet). During this period the temperature at altitudes of from 2,000 to 16,140 feet above sea-level ranged from $-6°$ F. to $+70°$ F. At her base camp, altitude 5,500 feet, three feet of snow fell in thirteen consecutive days, while at a camp 6,900 feet higher the snowfall during the same period, which included four days of hot sun, was very much greater. It was measured by the burial of bamboo poles 12 feet long in front of a shelter excavated in the snow and may be estimated at 30 feet (packed to 10 feet). At the summit of Mount Blackburn the snowfall seems to be less, though it may be all carried away by the winds. An important part of the alimentation of Kennicott Glacier comes in great snow avalanches from the steep walls of its valley. Some of these avalanches, which are most abundant between noon and 4:00 P.M., advance three miles from the valley wall, or the whole width of the glacier.

Prince William Sound.—Barry Glacier in Harriman Fiord retreated an amount varying from about 2,500 feet on the western side to at least 7,200 feet on the eastern border between Martin's visit in July, 1910, and Johnson's in 1913. Coxe Glacier, formerly a tributary of the Barry is now independent.

[1] *World's Work*, XXVII (1913), 80–101.

Cook Inlet.—A glacier at the head of Tuxedni or Snug Harbor seems to have advanced between 1904 and 1911. Coast Survey Chart 8554 shows some of the glaciers on Mount Iliamna for the first time and new details of the glaciers on Mount Douglas.

In 1913 Archdeacon Stuck found that a marked change had taken place in one of the great ridges of Mount McKinley since Parker's ascent in 1912; the snow and ice had broken away from a larger portion of the ridge, owing, possibly, to the earthquake of July 6, 1912.

In the absence of M. Charles Rabot, the retiring president of the Commission International des Glaciers, his report to the Twelfth International Congress of Geologists at Toronto was presented by Mr. Emile de Margerie.[1] It may be summarized as follows:

At present the glaciers throughout the world are in general retreating. Though in some regions, as Iceland, the retreat is slight, in others, such as Alaska, Norway, and the Alps, it is very marked. Thus in the Pelvoux *massif*, several small glaciers have entirely disappeared in the last thirty years.

The retreat, which has lasted for a century in Norway, and for fifty or sixty years in the Alps has been interrupted by small temporary advances. In Norway an advance in the last few years is dying out; in the French Alps and in the Pyrenees a secondary advance is developing.

A careful search of old documents has revealed the variations of the Chamonix glaciers since 1580. A strong advance occurred during the last years of the sixteenth century; others in 1643, in 1663, and in 1716; the last culminated only about 1741. The variations since then were already known: a new advance began near the end of the eighteenth century, reached its maximum in 1818–20, and continued, but in a mild form, until the middle of the nineteenth century; since then the glaciers have been in retreat. It seems that the advance about 1600 was greater than had occurred for several generations before that date; and that, since then, the glaciers have not been as reduced as they are at present. In Norway, also, branches of the Jostedalsbrae and of the Svartisen advanced strongly in the first quarter of the eighteenth century; and in Iceland an increase of the glaciation seems to have existed

[1] The report is printed in the *Comptes rendus* of the Congress, pp. 144–48, and in *Zeitschrift für Gletscherkunde*, VIII (1914), 263–69.

since the tenth century. These records lead to the conclusion that glaciers are subject to variations of two orders: primary variations of great amplitude and of unknown duration; and, superposed on them, secondary variations, which, in the Alps, appear to follow Brückner's law. These oscillations are due to climatic variations, and it is advisable that brief reports of the snowfall should accompany the records of glacier variations.

Since the last congress the commission has suffered severely by the deaths of F. A. Forel, who may be looked upon as the originator of the study of glacier variations; of K. J. V. Steenstrup, who has done such excellent work in Greenland; and of R. S. Tarr, well known for his studies in Alaska. M. Paul L. Mercanton, of Lausanne, succeeds M. Forel as the ordinary member for Switzerland; M. Paul Harder takes the place of M. Steenstrup representing Denmark; and Mr. Alan G. Ogilvie now represents Great Britain in the place of Mr. Freshfield, who has retired and become a corresponding member. Other corresponding members elected recently are: Messrs. J. Rekstad, Adolf Holl, A. O. Wheeler, Lawrence Martin, and F. E. Matthes.

The officers of the commission elected to serve until the next meeting of the International Congress of Geologists are: Honorary President, Prince Roland Bonaparte; Active President, Dr. Axel Hamberg; Secretary, Dr. Paul L. Mercanton.